Electrical Circuits (1)
Applications and Assignments

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1. Fundamentals

1.1 Problem

[sec:Ch1P1] Define the following quantities:

1. DC and AC currents
2. voltage
3. electrical power and energy

1.2 Problem

Calculate the power supplied or absorbed by each element in the circuit shown in Figure 1 also determine type of each element.

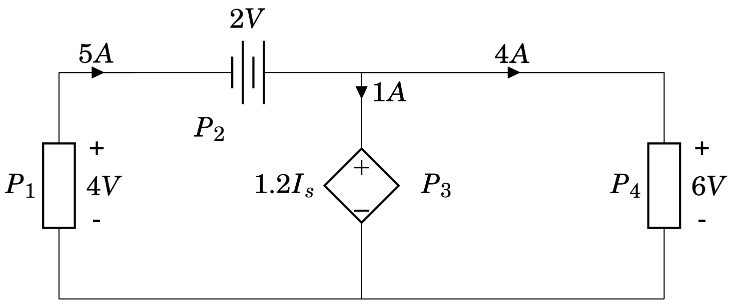


Figure 1

1.3 Problem

Define the following concepts:

1. node, branch and loop
2. planer circuit and non planer circuit
3. linear element and linear circuit
4. nonlinear element and nonlinear circuit

2. Basic laws and series circuis

2.1 Problem (Ohm's Law)

Write a short note about Ohm's law.

2.2 Problem (Series Circuits)

For the circuit shown in Figure 2 find:

1. the total resistance
2. the current I
3. the voltage drop across each resistor
4. the power dissipated by each resistor
5. the power delivered by the source and compare it to the sum of power consumed by resistors

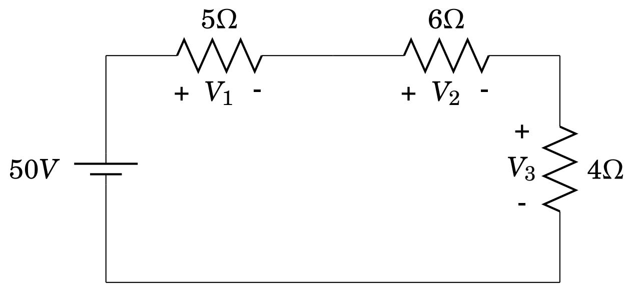


Figure 2

2.3 Problem (Series Circuits)

For the circuit shown in Figure 3 find:

1. the total resistance
2. the value of R_2
3. the voltage drop across each resistor
4. find the power dissipated in each resistor
5. the power delivered from the battery Is the power dissipated equals to the power delivered?

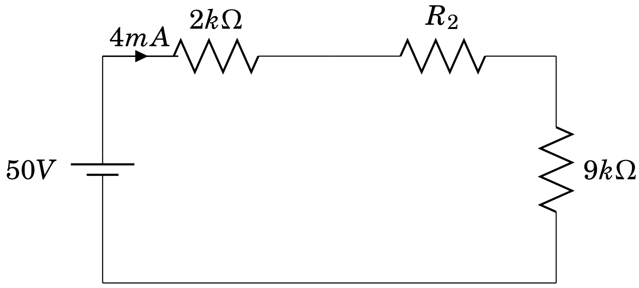


Figure 3

2.4 Problem (Kirchhoff's Laws)

Explain briefly Kirchhoff's voltage law. Support your answer with mathematical relations.

2.5 Problem (KVL)

Determine the unknown voltages for the circuit shown in Figure 4.

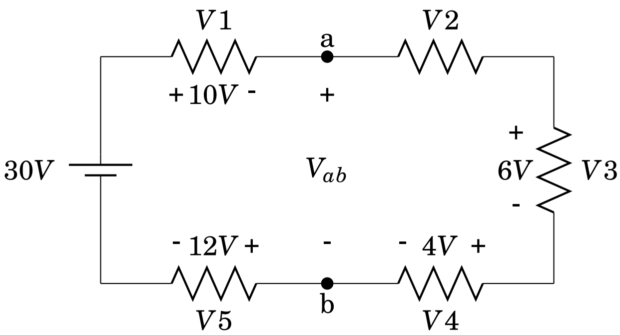


Figure 4

2.6 Problem

Determine the unknown voltages for the circuit shown in Figure 5.

2.7 Problem (Voltage divider)

Design the voltage divider circuit shown in Figure 6, such that $V_1 = 9V_2$.

2.8 Problem

Determine V_{ab}, V_{cb}, V_c and V_{ac} for the circuit shown in Figure 7.

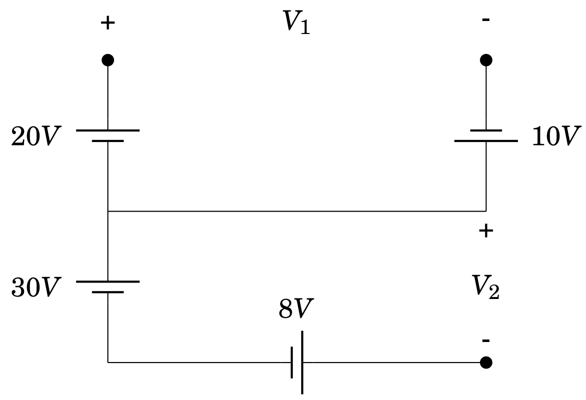


Figure 5

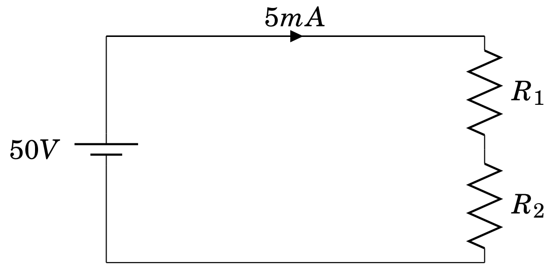


Figure 6

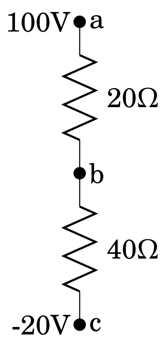


Figure 7

2.9 Problem (Internal resistance)

Find internal resistance of a battery that has no load output voltage of 100V and supplies a current of 3A to a load of 30Ω.

2.10 Problem (Internal resistance)

Find the load voltage and the power losses in the internal resistance for circuit shown in Figure 8.

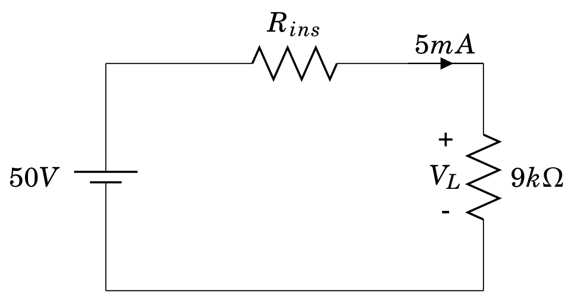


Figure 8

3. Parallel and Series-Parallel Circuits

3.1 Problem

For the circuit shown in Figure 9, find R_T

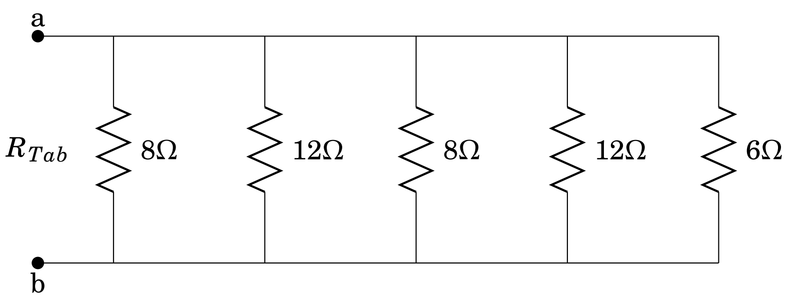


Figure 9

3.2 Problem

For the circuit shown in Figure 10, find R_1.

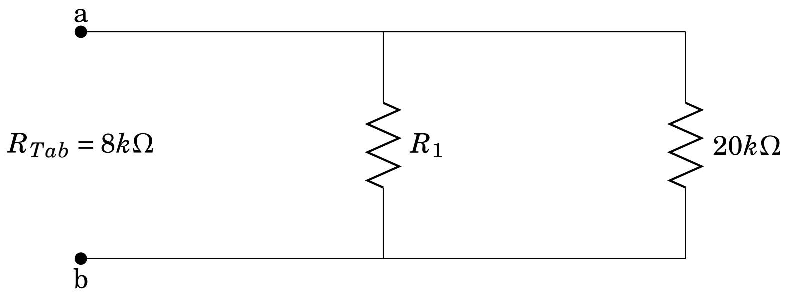


Figure 10

3.3 Problem

For the circuit shown in Figure 27, find: R_3, E, I_s, I_2 and P_2.

3.4 Problem

For the circuit shown in Figure 12, find: I_1, I_2, I_3 and I_s.

3.5 Problem

For the circuits shown in Figure 13, find I_o and I_x.

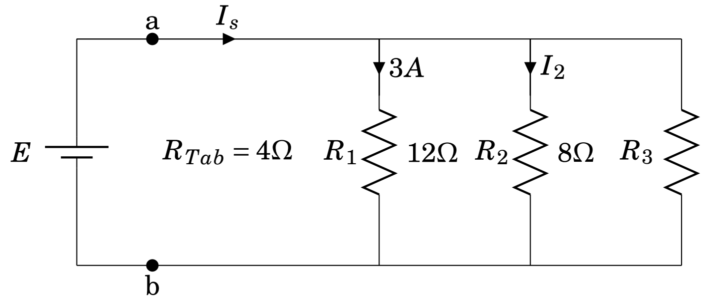


Figure 11

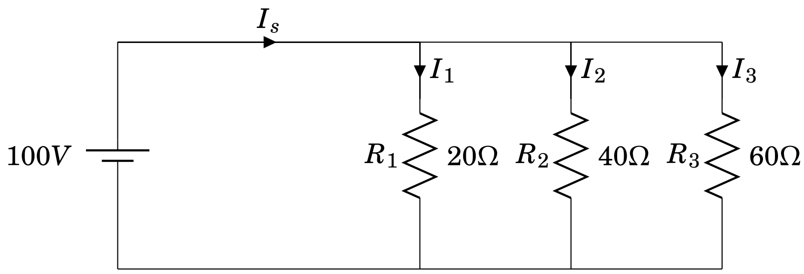


Figure 12

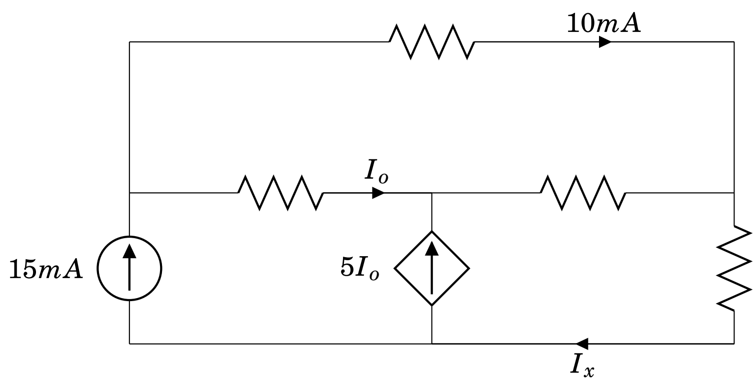


Figure 13

3.6 Problem

Find the short circuit current I and the open circuit voltage V for the circuit shown in Figure 14.

3.7 Problem

Find the current I and the open circuit voltage V for the circuit shown in Figure 15.

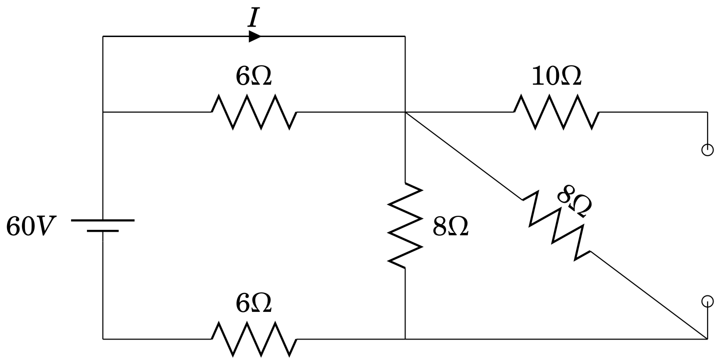


Figure 14

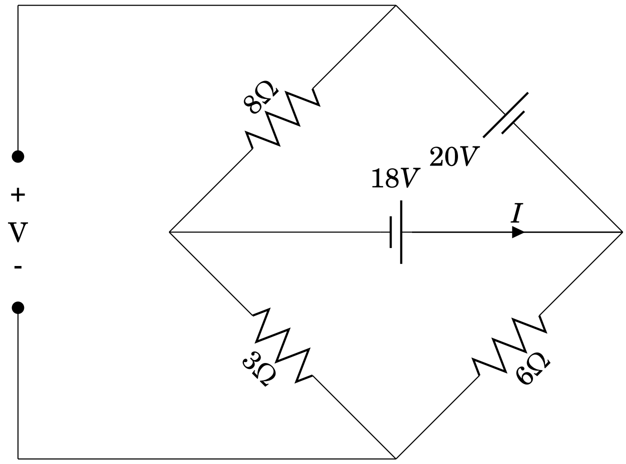


Figure 15

3.8 Problem

For the circuit shown in Figure 16, find the short circuit current I_o.

3.9 Problem

For the circuit shown in Figure 17,

1. Calculate the source current I_s.
2. Find the branch currents I_1 and I_2.

3.10 Problem

For the circuit shown in Figure 18, calculate the voltage drop V_5.

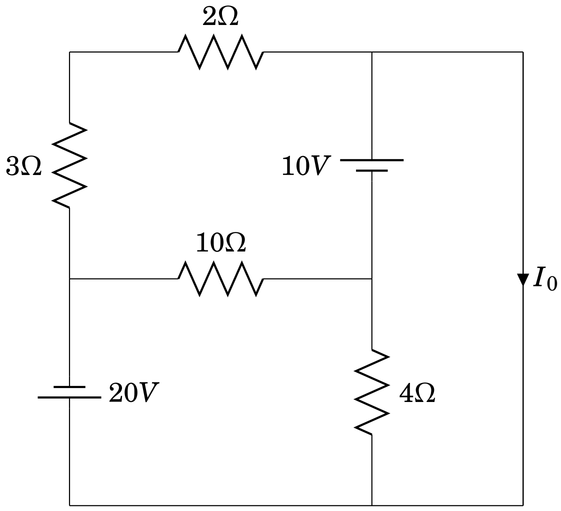


Figure 16

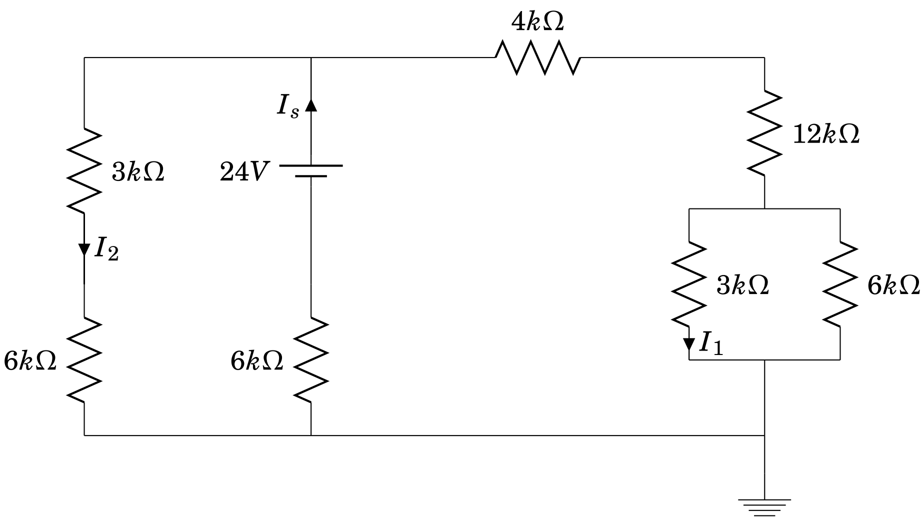


Figure 17

3.11 Problem

For the circuit shown in Figure 19, calculate:

1. V_o and I_o.
2. the power dissipated in 12Ω resistor.
3. the power developed by the current source.

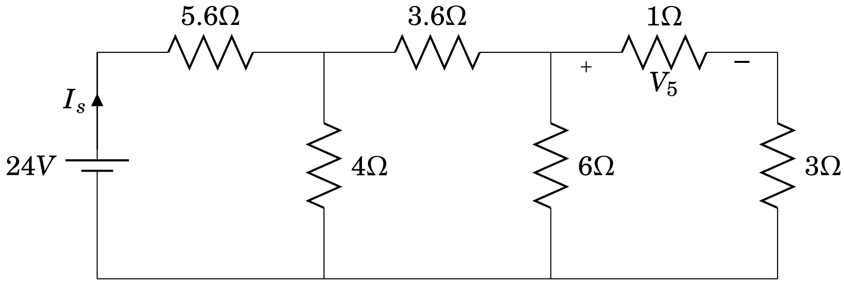


Figure 18

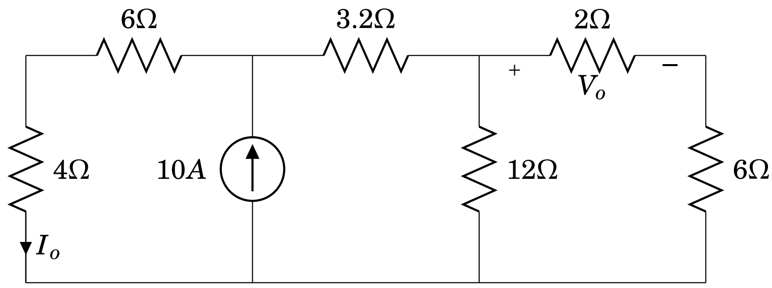


Figure 19

3.12 Problem

For the circuit shown in Figure 20, calculate the short circuit current.

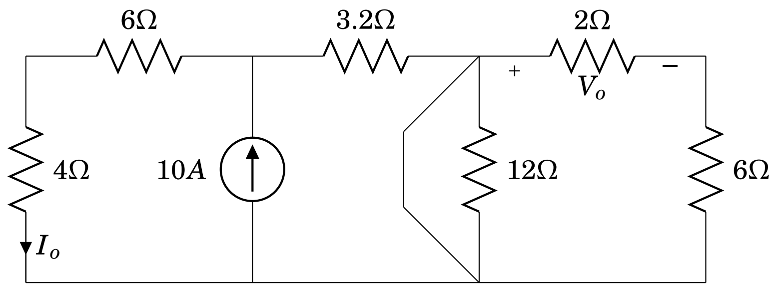


Figure 20

3.13 Problem

The current I_1 and I_2 in the circuit shown in Figure 21 are 10A and 25A respectively.

1. Find the power supplied by each voltage source.
2. Show that the total power supplied equals the total power dissipated in the resistors.

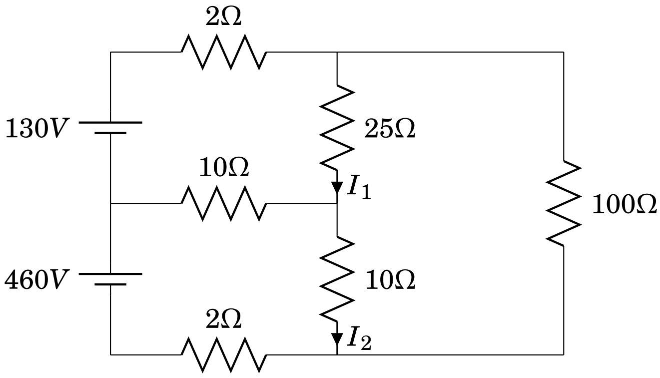


Figure 21

3.14 Problem

The current I_1 and I_2 in the circuit shown in Figure 22 are 2A and 4A respectively. Find,

1. the current I_s
2. the power dissipated in each resistor.
3. The voltage V_s.

Show that the total power developed equals the total power absorbed

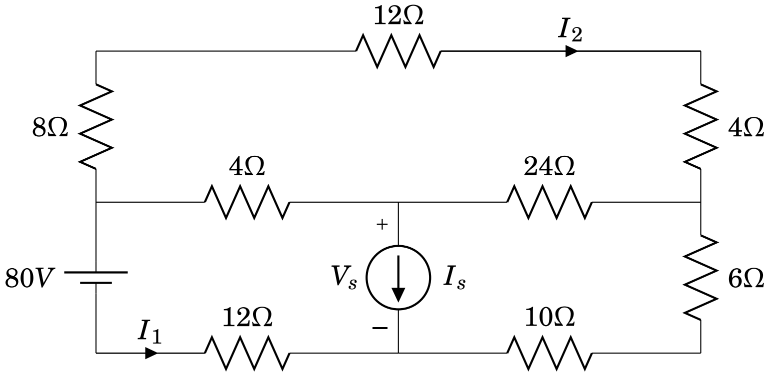


Figure 22

3.15 Problem

For the circuit shown in Figure 23, find, V_a, V_b and V_c. Find the same volages if $R_{L1} = R_{L2} = R_{L3} = 40k\Omega$.

3.16 Problem

For the circuit shown in Figure 24,

1. Design the voltage divider supply.
2. Can $4W$ resistor be used in the design?

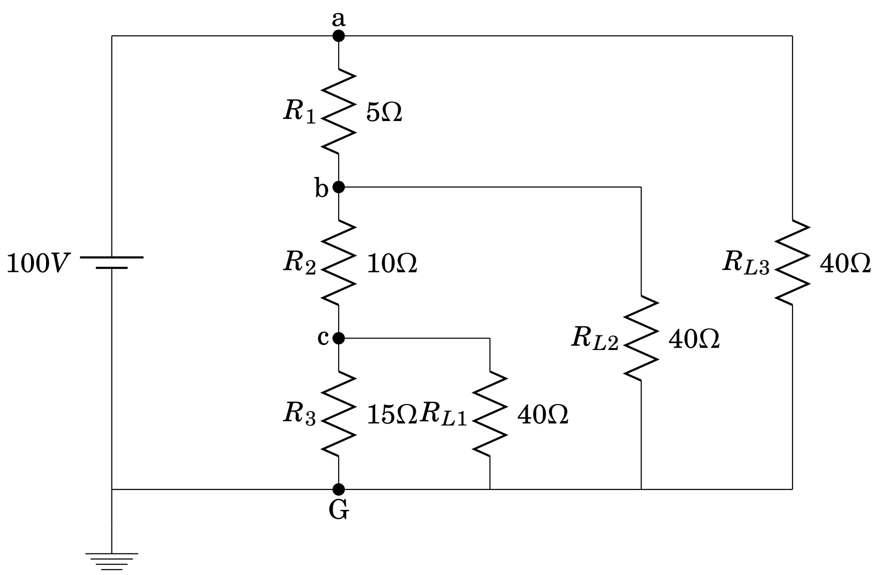


Figure 23

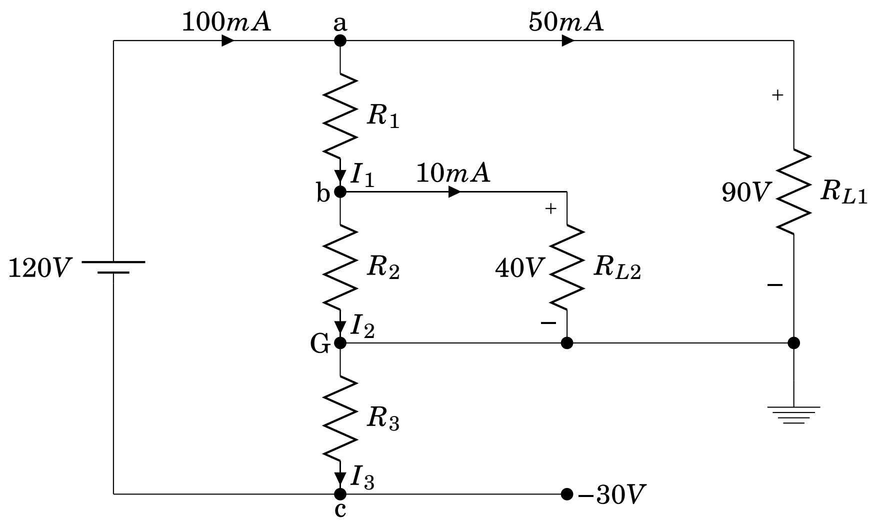


Figure 24

4. Sinusoidal Alternating Waveforms

4.1 Problem

What are the main advantageous of AC circuits rather than DC circuits?

4.2 Problem

Define the following quantities:

1. Waveform
2. Peak amplitude
3. Peak value
4. Peak-to-peak value
5. Periodic waveform
6. Period
7. Frequency

4.3 Problem

For the waveform shown in Figure (4.1), vertical sensitivity is 0.2 V/div and the horizontal sensitivity is 20 μ sec/div. Calculate the peak value V_m, the peak-to-peak value and the period and the frequency f.

4.4 Problem

Given that $\omega = 314$ Rad/sec, determine how long a sinusoidal wave will take to pass through an angle of $45°$.

4.5 Problem

For the function, $v = 20 \sin(314t)$,

- find the angle at which the magnitude is $10V$.
- determine the time at which the magnitude is attained.

4.6 Problem

Sketch $v = 100 \sin(314t)$ againest

- angle ωt in degrees.
- angle ωt in radians.
- time (t) in milliseconds.

4.7 Problem

What is the phase relationship between the sinusoidal waveforms of each of the following cases?

1. $v = 50\sin(\omega t + 60°)$, $i = 10\sin(\omega t + 90°)$
2. $v = 10\sin(\omega t + 60°)$, $i = 10\sin(\omega t - 30°)$
3. $v = 20\sin(\omega t - 20°)$, $i = 2\cos(\omega t + 30°)$
4. $v = 10\sin(\omega t + 20°)$, $i = -5\sin(\omega t + 30°)$
5. $v = 25\sin(\omega t - 150°)$, $i = -5\cos(\omega t - 10°)$

4.8 Problem

Determine the delay time in milliseconds between the following two waves; $v = 100\sin(377t + 30°)$ and $i = 1.2\sin(377t - 30°)$.

4.9 Problem

Define the following terms:

1. Average value of AC waveforms, and
2. RMS (Effective) value of AC waveforms.

4.10 Problem

Find the average value effective value of the periodic waveforms of Figure (4.2) over one period.

4.11 Problem

Find the effective value of $i = I_m \sin(\omega t + \theta_i)$.

4.12 Problem

Find the average and effective values of the following waveforms:

1. $i = 10\sin(314t + 60°)mA$
2. $i = 5\cos(314t + 30°)A$
3. $v = 100\sin(314t)V$
4. $v = 100\sqrt{2}\sin(377t + 50°)V$

4.13 Problem

Find the average and effective values of waveform shown in Figure (4.3)

4.14 Problem

Sketch the following voltage and current in time domain and in phasor diagram:

1. $v(\omega t) = 100\sin(\omega t + 30°)V$
2. $i(\omega t) = 10\sin(\omega t - 60°)A$

4.15 Problem

The voltage is given as $v(\omega t) = 200\sin(314t + 60°)$. Find the sinusoidal expression for the circuit current if the load is:

1. a resistor of 10Ω.
2. an inductor of 10Ω.
3. a capacitor of 10Ω.

Sketch v and i against angle. Also sketch the phasor diagram for each case.

4.16 Problem

Determine the phase angle, power factor and load type and its value for the following cases:

1. $v = 100\sin(\omega t + 60°)$ and $i = 2\sin(\omega t + 60°)$
2. $v = 200\sin(314t + 60°)$ and $i = 10\sin(314t - 30°)$
3. $v = 250\sin(314t + 60°)$ and $i = 10\sin(314t + 150°)$
4. $v = 220\cos(314t)$ and $i = 20\sin(314t)$

4.17 Problem

1. At what frequency will the reactance of $20mH$ inductor match the resistance level of $20k\Omega$.
2. At what frequency will the reactance of $20\mu F$ inductor match the resistance level of $20k\Omega$.
3. At what frequency will the reactance of $20mH$ inductor have the reactance as a capacitor of $20\mu F$?

4.18 Problem

Determine the power factor and average power delivered to the circuit for the following cases:

- $I = 0.5\angle 40° A$, $V = 45\angle 70° V$
- $I = 1.0\angle -60° A$, $V = 100\angle 0° V$
- $v = 220\sqrt{2}\sin(314t + 30°)$, $i = 10\sqrt{2}sin(314t + 40°)$
- $v = 100\sqrt{2}\sin(314t + 50°)$, $i = 5\sqrt{2}sin(314t - 10°)$

5. SERIES AND PARALLEL AC CIRCUITS

5.1 Problem

1. Using complex algebra, find the current i for the circuit shown in Figure 25, also sketch the waveforms of v and i.

2. Repeat if resistance is replaced by inductive reactance of 10Ω.

3. Repeat if resistance is replaced by capacitive reactance of 10Ω.

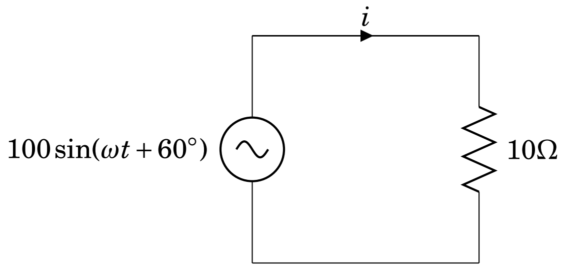


Figure 25

5.2 Problem

For the circuit shown in Figure 26,

1. find Z_T, I, V_R and V_L.

2. Draw the impedance diagram and the phasor diagram of the circuit, if the supply voltage is $v = 200\sqrt{2}\sin(377t)$V

3. repeat if the inductor is replaced by capacitor of 442.087μF.

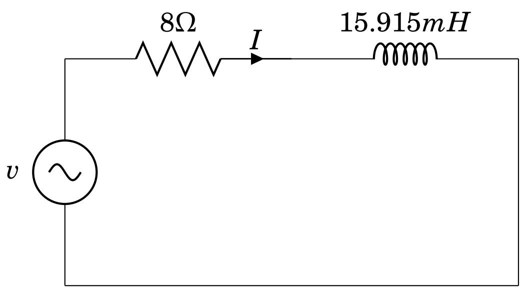


Figure 26

5.3 Problem

For the circuit shown in Figure 27, find Z_T, I, V_R, V_L and V_C. Is the Kirchhoff's voltage law is satisfied for the circuit? Find the total power delivered from the supply and power losses through resistance, inductor and capacitor. Is power delivered from supply equal to that dissipated through loads? Find, the circuit power factor. Draw the impedance and the phasor diagrams of the circuit, if the supply voltage is $e = 200\sqrt{2}\sin(\Omega t)$V.

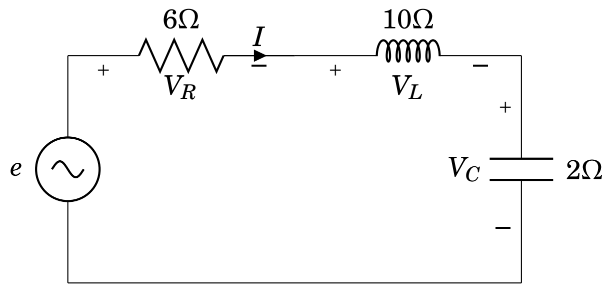


Figure 27

5.4 Problem

For the circuit shown in Figure 28, find Z_T, I, V_R, V_L and V_C. The supply voltage is $e = 200\sqrt{2}\sin(314t)$V.

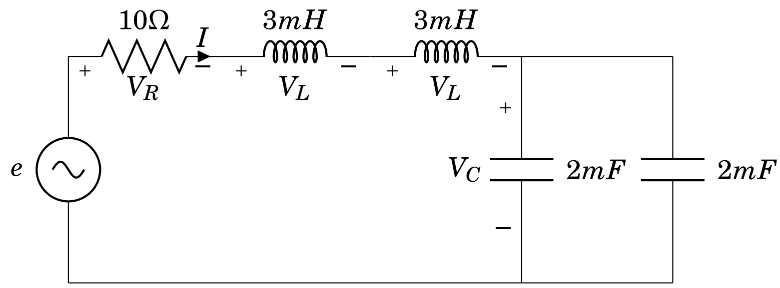


Figure 28

5.5 Problem

For the circuit shown in Figure 29, sketch Z_T, θ_T, I, V_R, V_C, θ_R and θ_C versus frequency for frequency changes from zero to infinity.

5.6 Problem

For the circuit shown in Figure 30, sketch Z_T, θ_T, I, V_R, V_L, θ_R and θ_C versus frequency for frequency changes from zero to infinity.

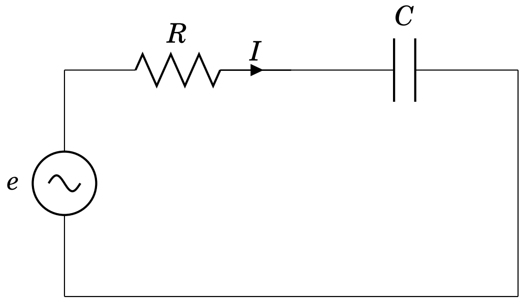


Figure 29

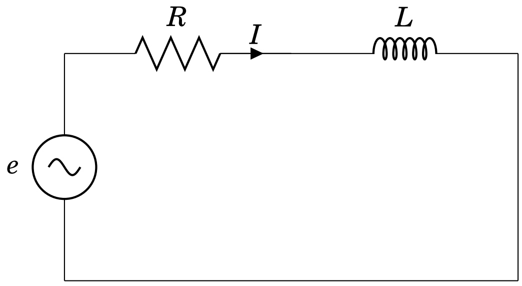


Figure 30

5.7 Problem

For the circuit shown in Figure 31, find:

1. the total impedance
2. currents I_1, I_2 and I_s.
3. The power delivered to the circuit.

Is KCL satisfied for the circuit? Sketch phasor diagram and admittance diagram.

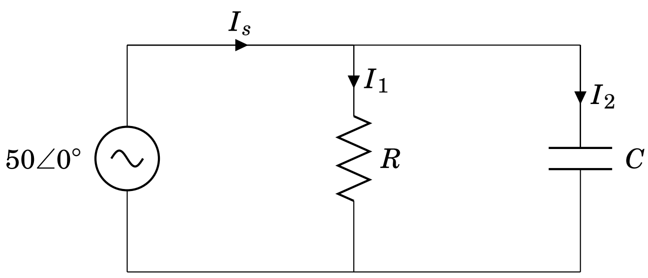


Figure 31

5.8 Problem

For the circuit shown in Figure 32, find:

1. the total admittance and impedance in polar coordinate.
2. value of C and L.
3. the I_s, I_R, I_L and I_C.
4. the average power delivered to the circuit.
5. the power factor of the circuit.

Verify KCL at one node. Draw the phasor diagram of E, I_R, I_L, I_C and I_s. Plot the currents and voltage on the same set of axes.

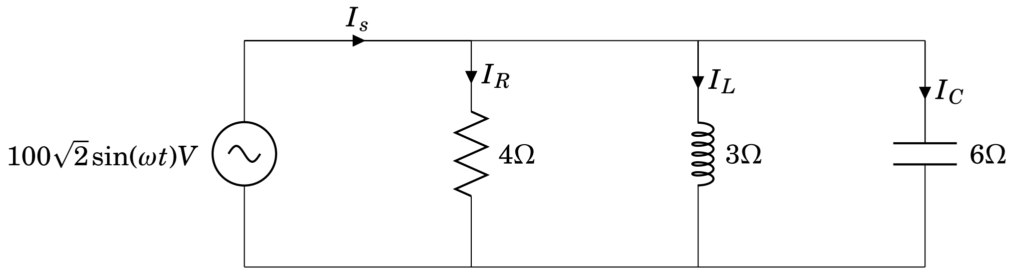


Figure 32

5.9 Problem

Sketch Z_T, θ_T, I, V_R, V_C, θ_R and θ_C versus frequency for frequency changes from zero to infinity for the circuit shown in Figure 33.

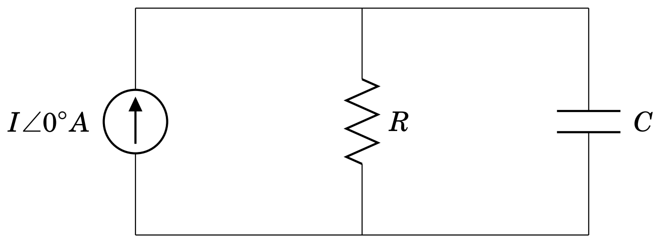


Figure 33

5.10 Problem

Repeat the previous problem for parallel RC circuit.

5.11 Problem

For the circuit shown in Figure 34, find:

1. he volage V_L using voltage divider rule.
2. the current I_T.

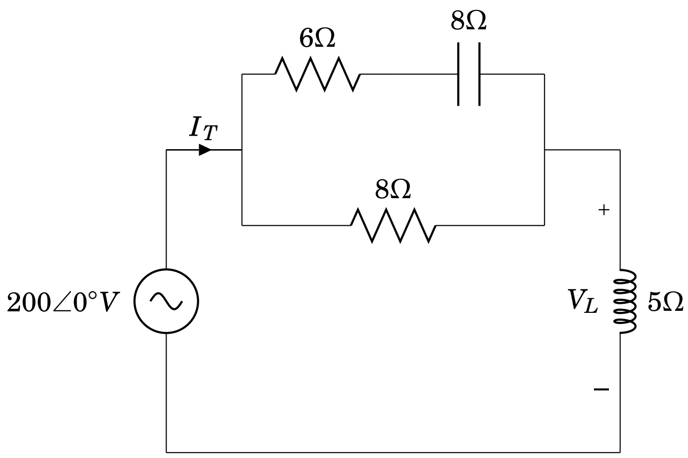


Figure 34

5.12 Problem

For the circuit shown in Figure 35, find Z_T, Y_T, I_T, I_2 and I_3.

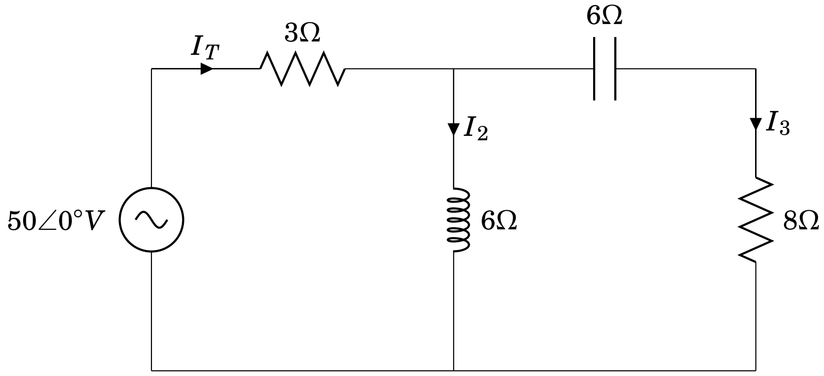


Figure 35

5.13 Problem

For the circuit shown in Figure 36, calculate I_o.

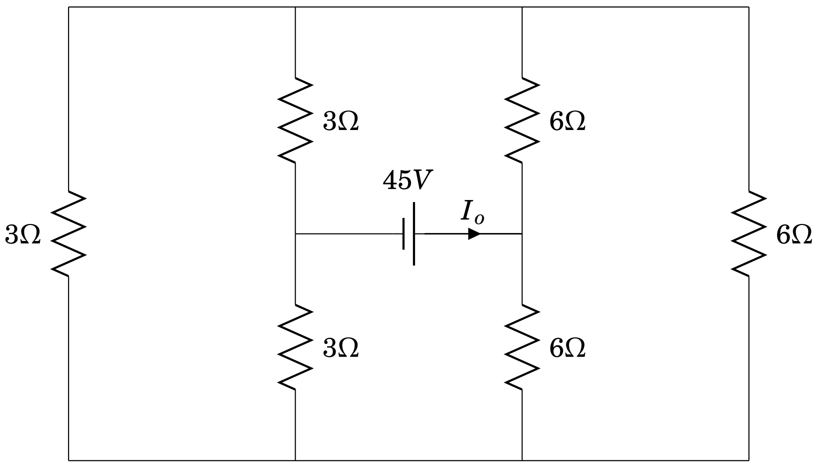


Figure 36

5.14 Problem

For the circuit shown in Figure 37, calculate I_6.

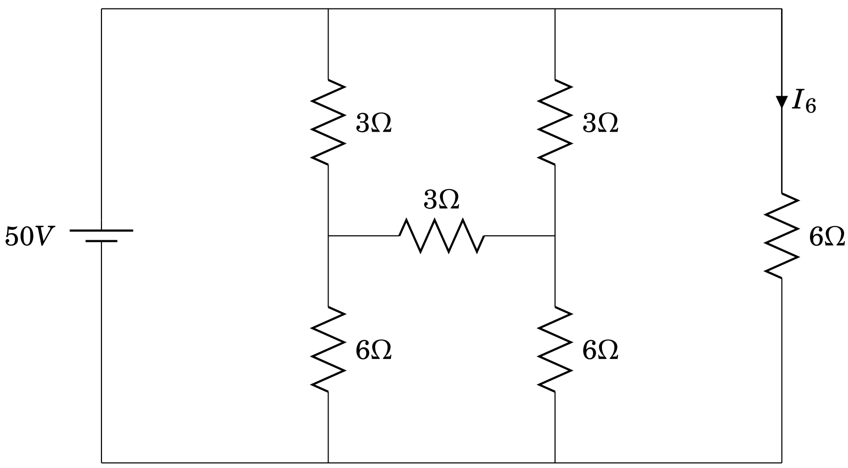


Figure 37

6. METHODS OF ANALYSIS

6.1 Problem

For the circuit shown in Figure 38, use source transformations to find the voltage V. How much power does the 120V source delivers to the circuit?

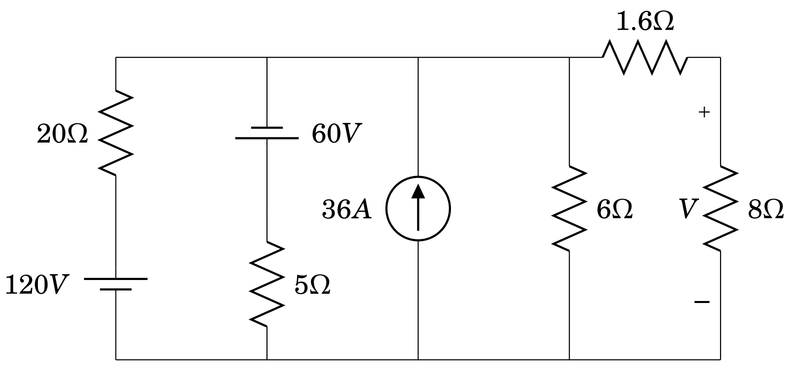


Figure 38

6.2 Problem

For the circuit shown in Figure 39, find the load current I_L.

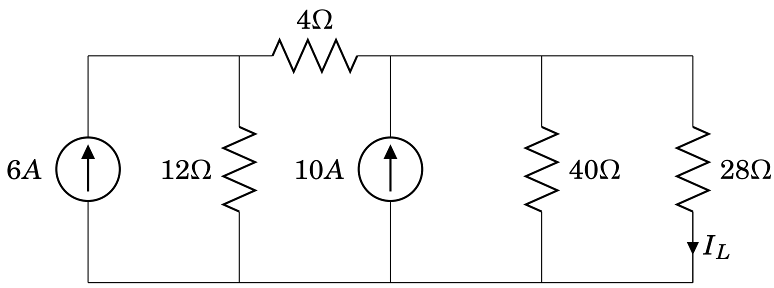


Figure 39

6.3 Problem

Find the branch currents in the circuit shown in Figure 40 using branch current method.

6.4 Problem

Find the branch currents in the circuit shown in Figure 41 using branch current method.

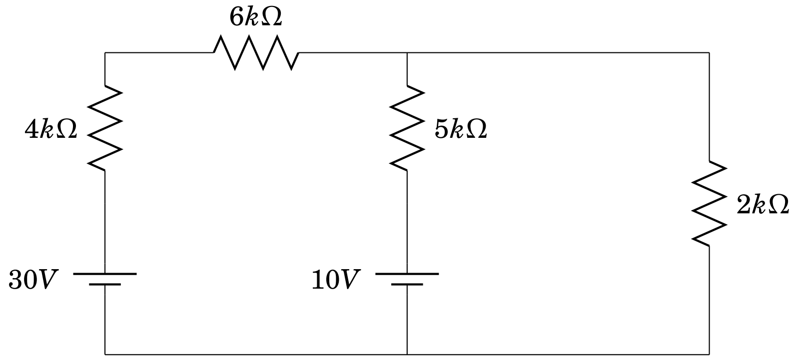


Figure 40

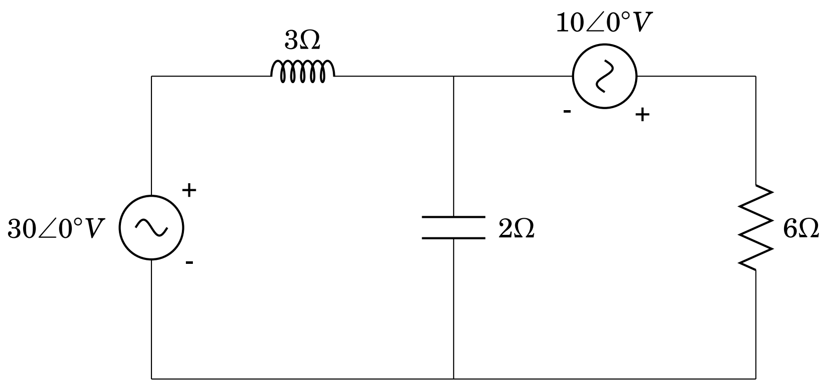


Figure 41

6.5 Problem

Repeat problem 6.3 using loop method.

6.6 Problem

Repeat problem 6.4 using loop method.

6.7 Problem

Find the branch current Ia in the circuit shown in Figure 42 using loop current method.

6.8 Problem

Write down the mesh current equations for the circuit shown in Figure 43. Solve for mesh current and determine the power loss in 3Ω resistor.

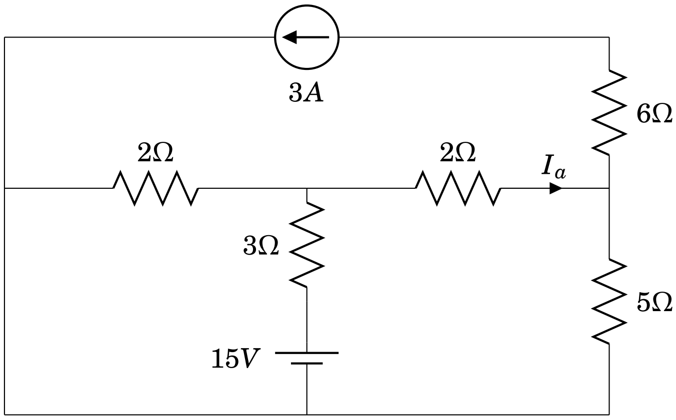


Figure 42

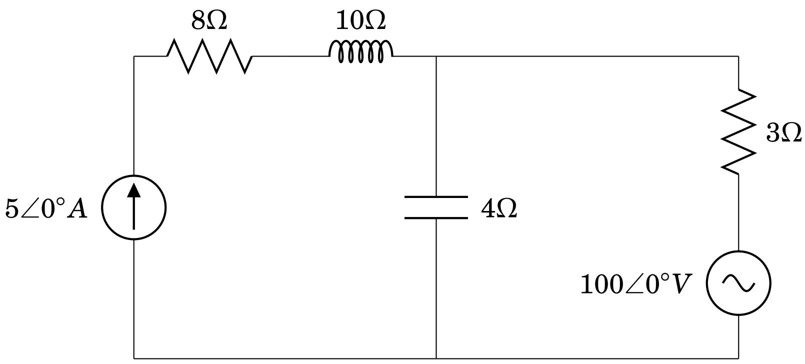


Figure 43

6.9 Problem

Write down the mesh current equations for the circuit shown in Figure 44. Solve for mesh current.

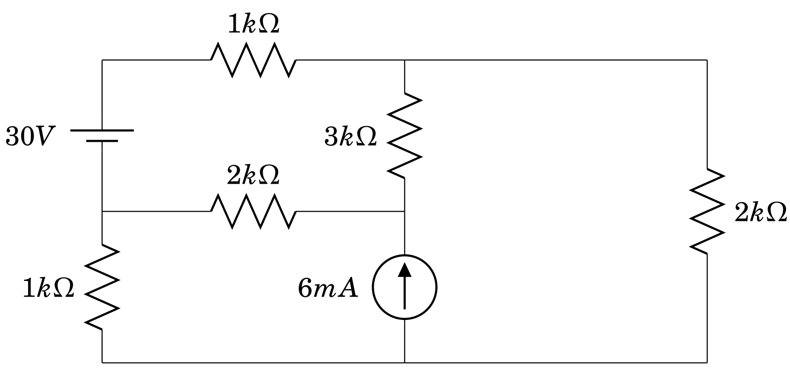


Figure 44

6.10 Problem

Find the current I_x in the circuit shown in Figure 45 using loop current method.

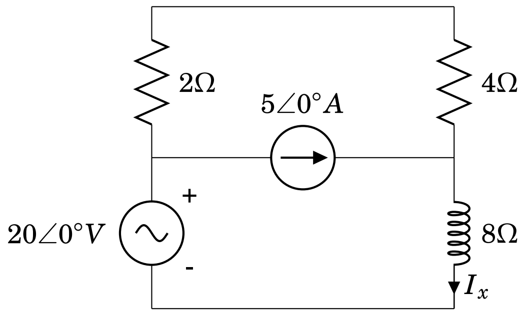


Figure 45

6.11 Problem

Write down the mesh current equations for the circuit shown in Figure 46. Solve for mesh current to calculate I_x.

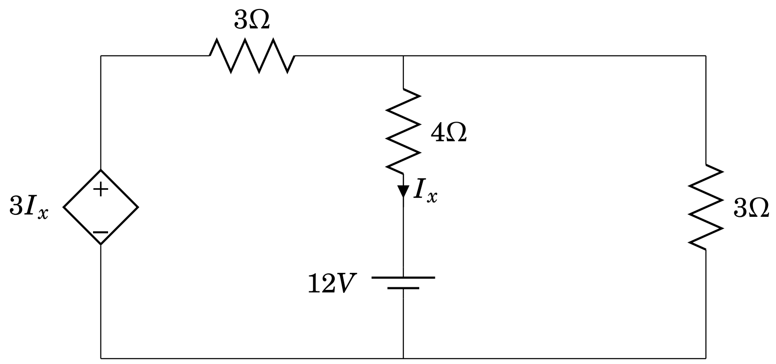


Figure 46

6.12 Problem

Write down the mesh current equations for the circuit shown in Figure 47. Solve for mesh current to calculate V_x.

6.13 Problem

Write down the mesh current equations for the circuit shown in Figure 48. Solve for mesh current to calculate I_x.

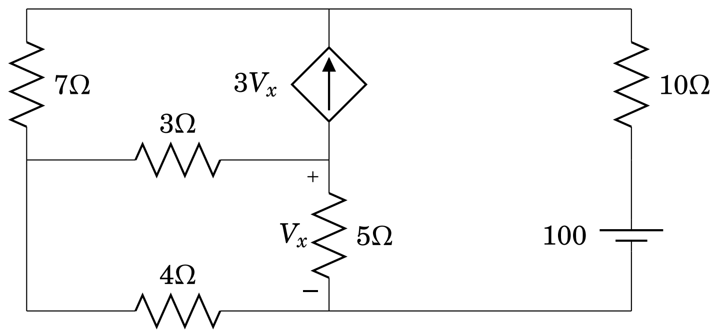


Figure 47

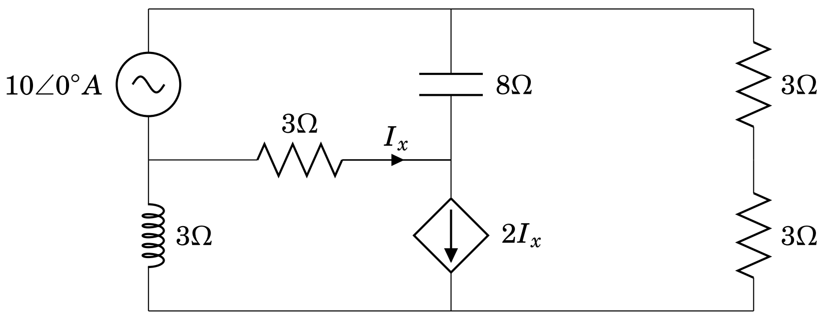


Figure 48

6.14 Problem

Apply node voltage method to the circuit shown in Figure 49. Determine branch currents.

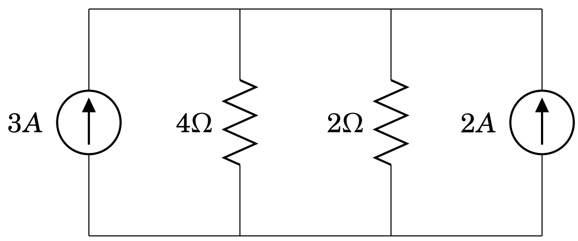


Figure 49

6.15 Problem

Apply node voltage method to the circuit shown in Figure 50. Determine branch currents. Calculate the summation of power delivered and summation of power dissipated.

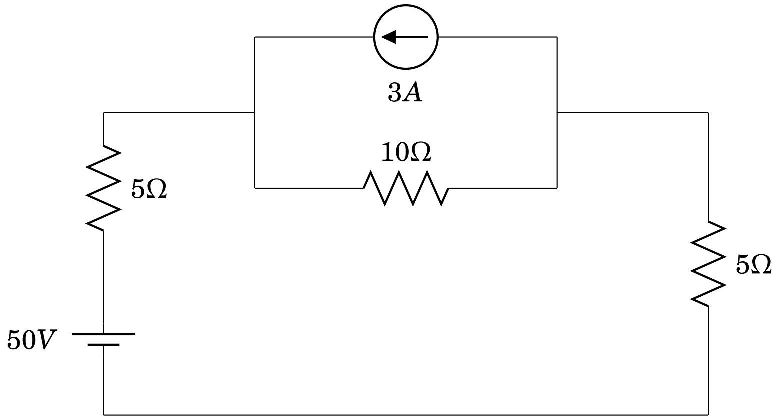


Figure 50

6.16 Problem

Apply node voltage method to the circuit shown in Figure 51. Determine branch currents I_o, I_x and I_y.

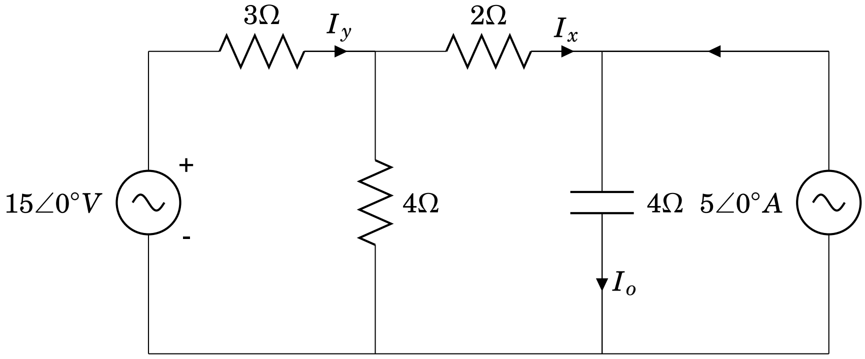


Figure 51

6.17 Problem

Apply node voltage method to the circuit shown in Figure 52. Determine branch currents I_o and find the power delivered from the voltage source.

6.18 Problem

Apply node voltage method to the circuit shown in Figure 53. Is the total power dissipated equals to the total power delivered?

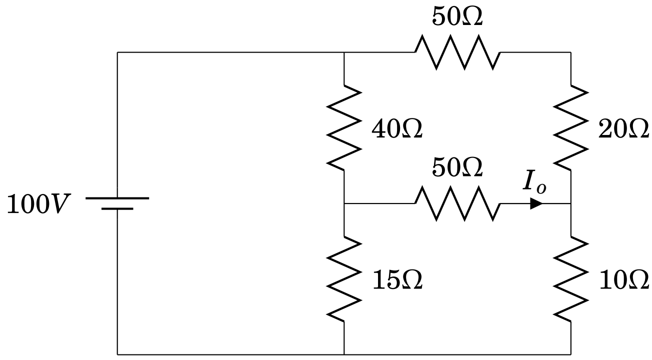


Figure 52

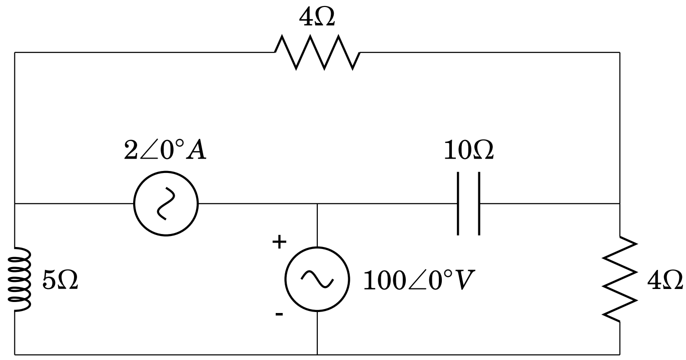


Figure 53

6.19 Problem

Use nodal method to calculate I_o in the circuit shown in Figure 54.

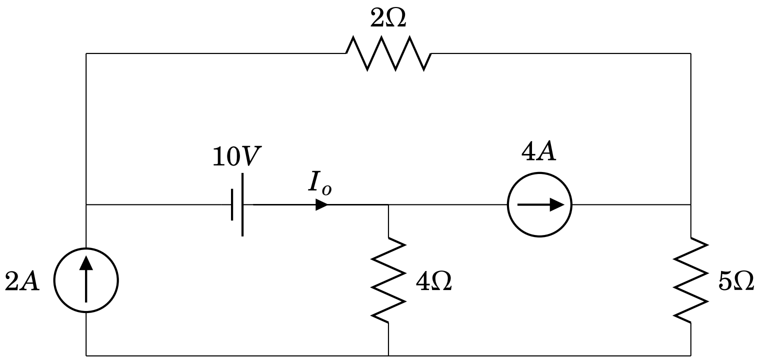


Figure 54

6.20 Problem

Use super node voltage method to calculate the power loss in 2Ω resistor in the circuit shown in Figure 55.

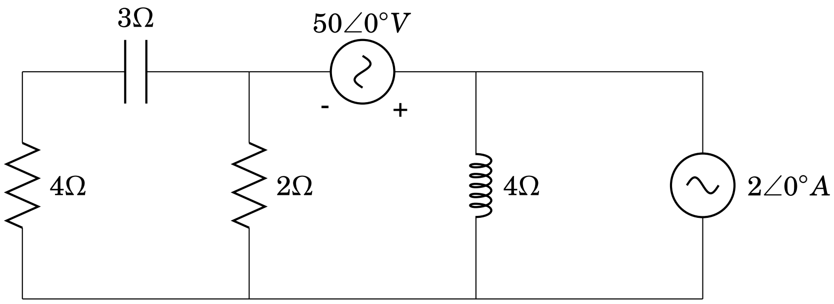


Figure 55

6.21 Problem

For the circuit shown in Figure 56, use node voltage method to calculate the power delivered from dependent source.

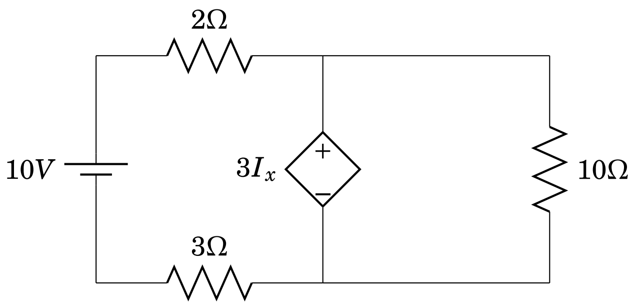


Figure 56

6.22 Problem

For the circuit shown in Figure 57, use node voltage method to calculate I_C.

6.23 Problem

For the circuit shown in Figure 58, calculate the source current and I_o and I_20. Recalculate the currents, if 20ω resistor is replaced by 30Ω.

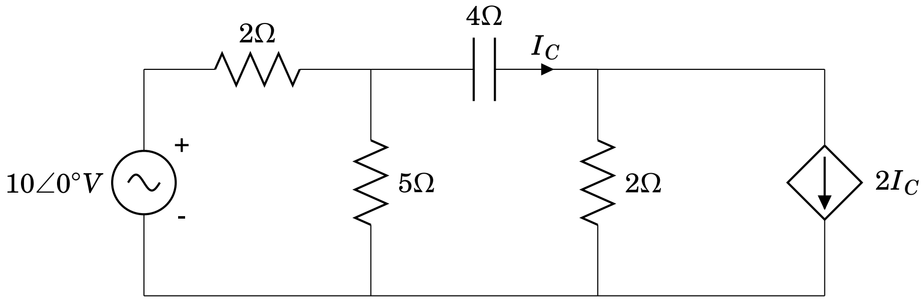


Figure 57

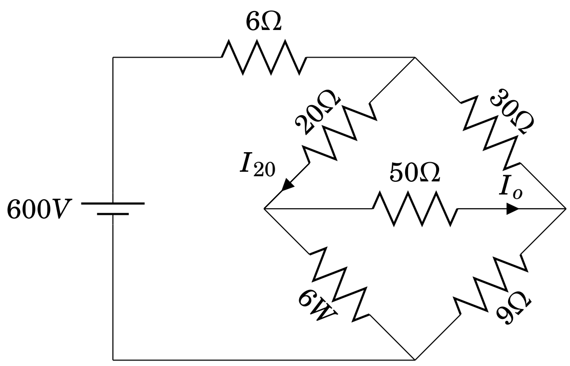


Figure 58

6.24 Problem

For the circuit shown in Figure 59, use loop current method to calculate the currents I_s and I_o. Is the bridge is balanced?

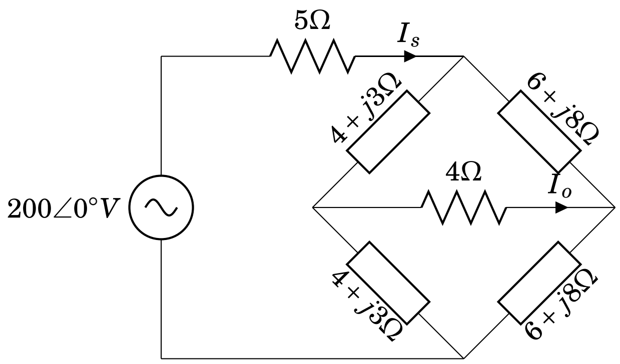


Figure 59

7. Network Theorems

7.1 Problem

For the circuit shown in Figure 60, use superposition to calculate the branch currents. Find the voltage drop across each resistance. Also, find the power loss through each resistor.

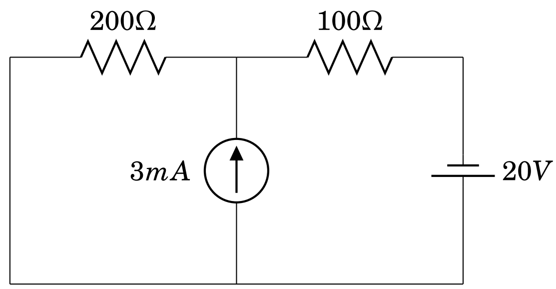


Figure 60

7.2 Problem

For the circuit shown in Figure 61, use superposition to calculate the power loss through 40ω resistor.

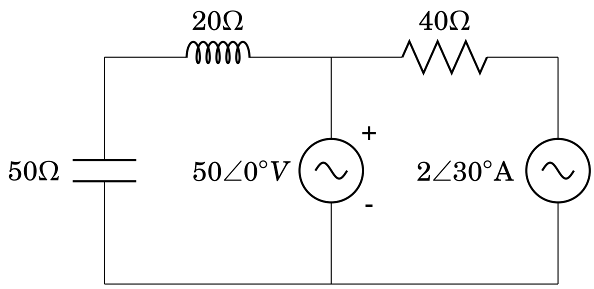


Figure 61

7.3 Problem

For the circuit shown in Figure 62, use superposition to calculate the current drop I_x and the total power dissipated.

7.4 Problem

For the circuit shown in Figure 63, use superposition to find the sinusoidal expression of inductor current. (Take frequency with 50Hz)

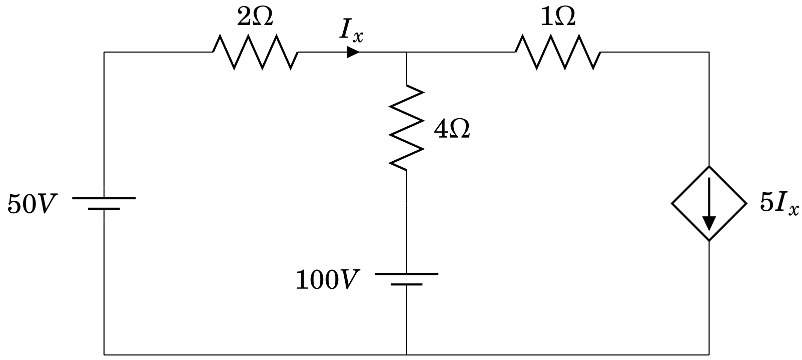


Figure 62

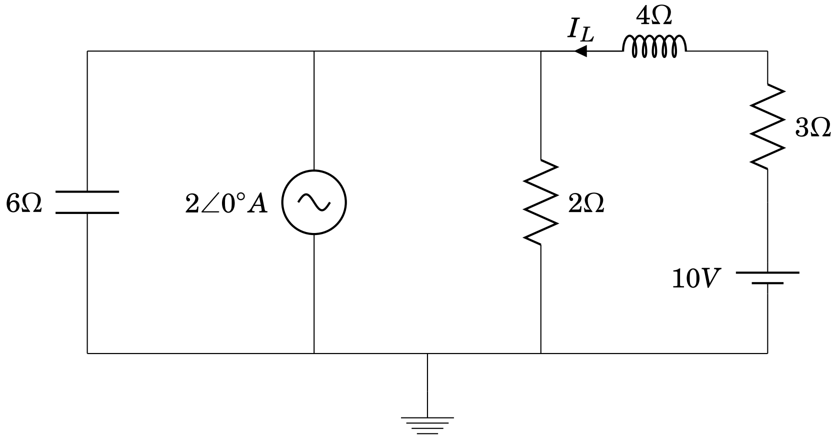


Figure 63

7.5 Problem

For the circuit shown in Figure 64, find the Thevenin and Norton equivalent circuits to the circuit between a and b.

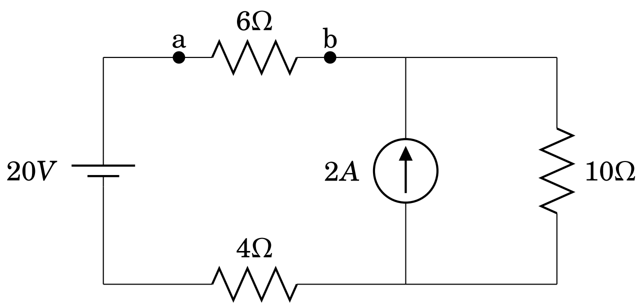


Figure 64

7.6 Problem

For the circuit shown in Figure 65, find the Thevenin and Norton equivalent circuits to circuit external 30Ω resistor, then calculate the power dissipated through it.

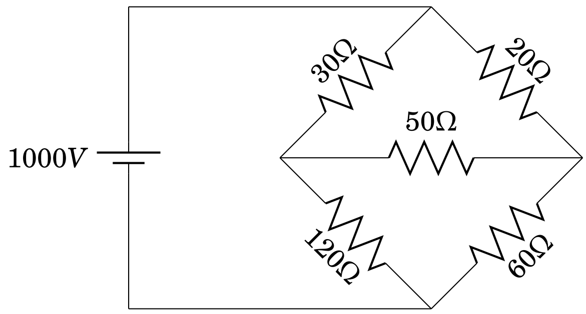


Figure 65

7.7 Problem

For the circuit shown in Figure 66, find the Thevenin and Norton equivalent circuits to circuit external 10ω resistor, then calculate the power dissipated through it.

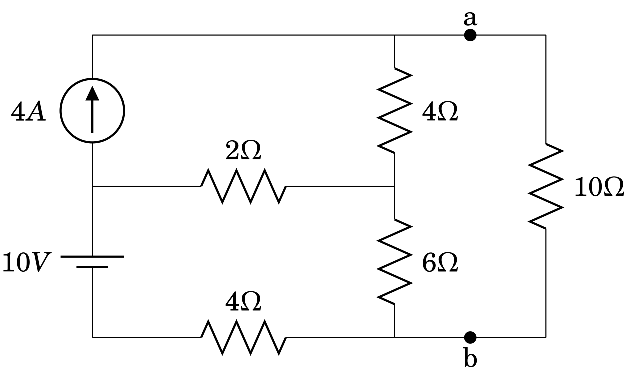


Figure 66

7.8 Problem

For the circuit shown in Figure 67, find the Thevenin and Norton equivalent circuits to circuit external Z_L.

7.9 Problem

For the circuit shown in Figure 68, find the Thevenin and Norton equivalent circuits to circuit external RL.

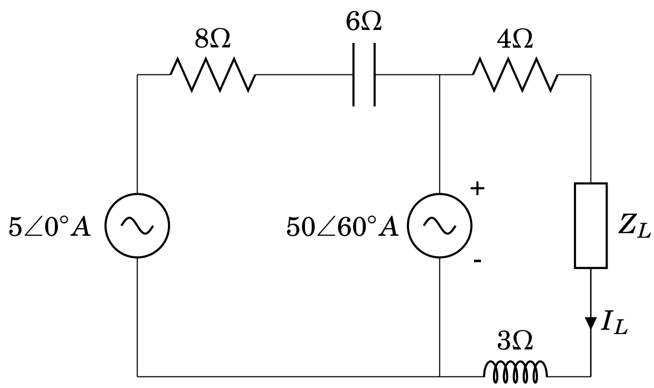


Figure 67

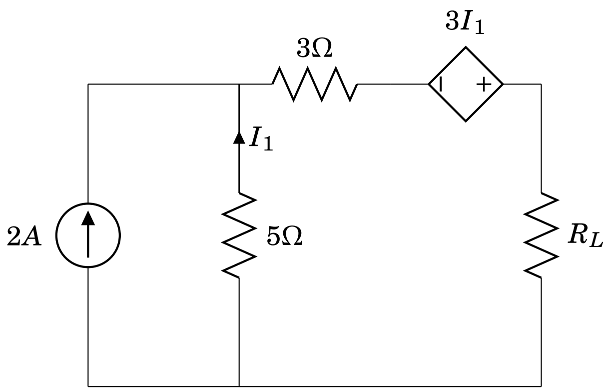


Figure 68

7.10 Problem

For the circuit shown in Figure 69, find the power dissipated by 6Ω resistor using Thevenin theorem.

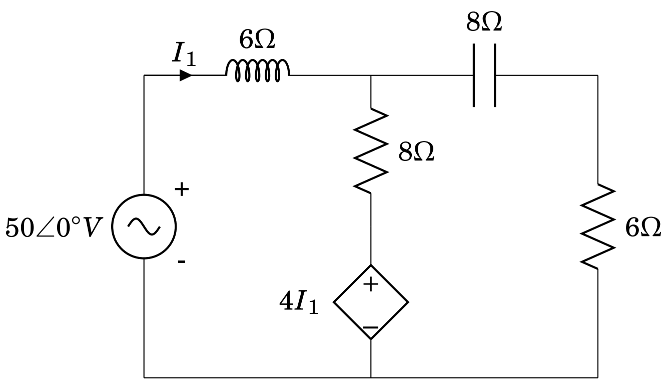


Figure 69

7.11 Problem

For the circuit shown in Figure 70, find value of R_L to delivered maximum power from the network then evaluate maximum power.

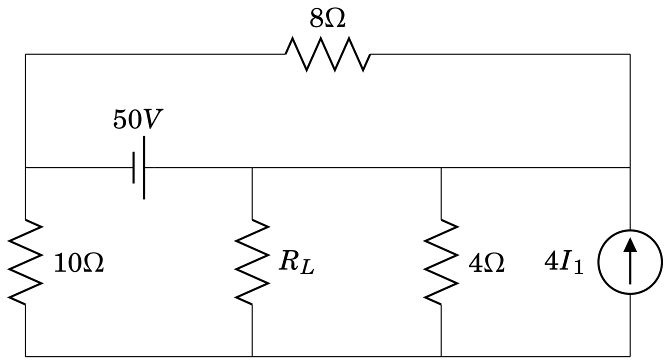


Figure 70

7.12 Problem

For the circuit shown in Figure 71, find value of Z_L to delivered maximum power from the network then evaluate maximum power.

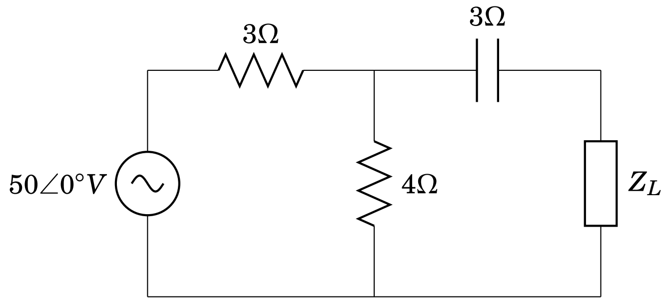


Figure 71

7.13 Problem

For the circuit shown in Figure 72, find the load current I_L.

7.14 Problem

For the circuit shown in Figure 73, find the load current I_L.

7.15 Problem

For the circuit shown in Figure 74, find the load current I_L.

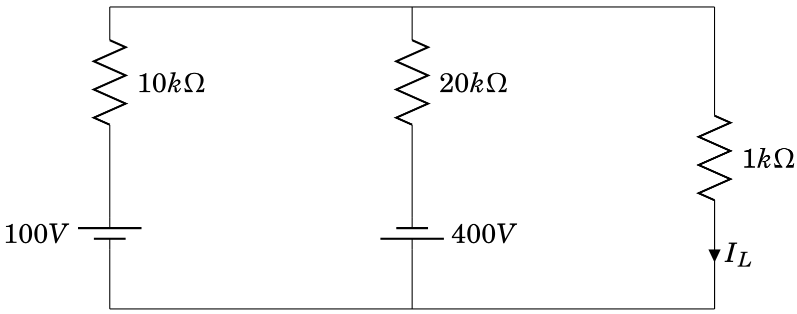


Figure 72

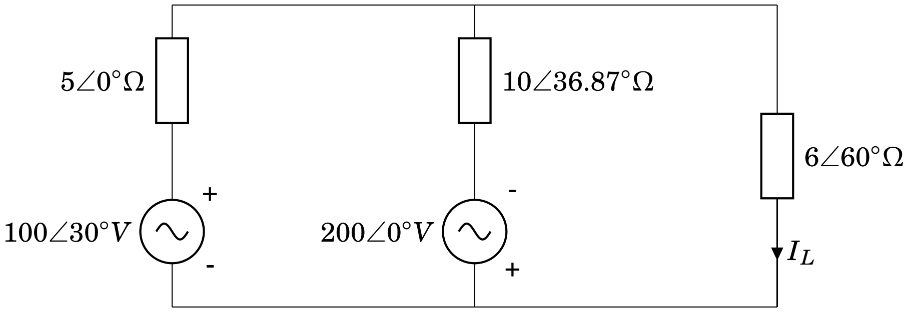


Figure 73

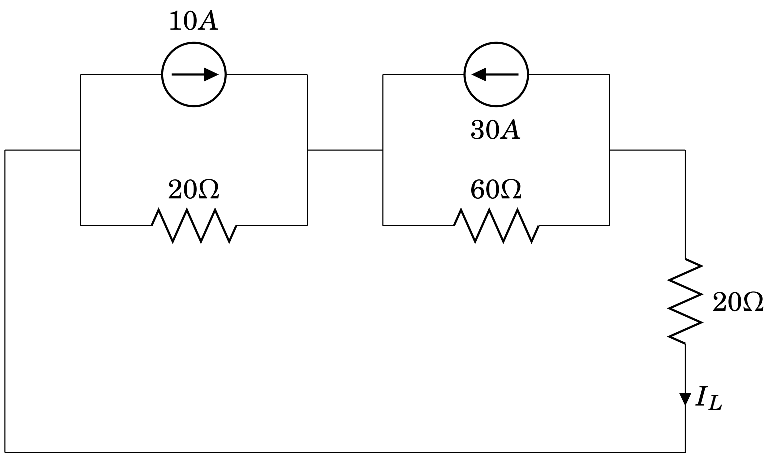


Figure 74

7.16 Problem

For the circuit shown in Figure 75, find the load current I_L.

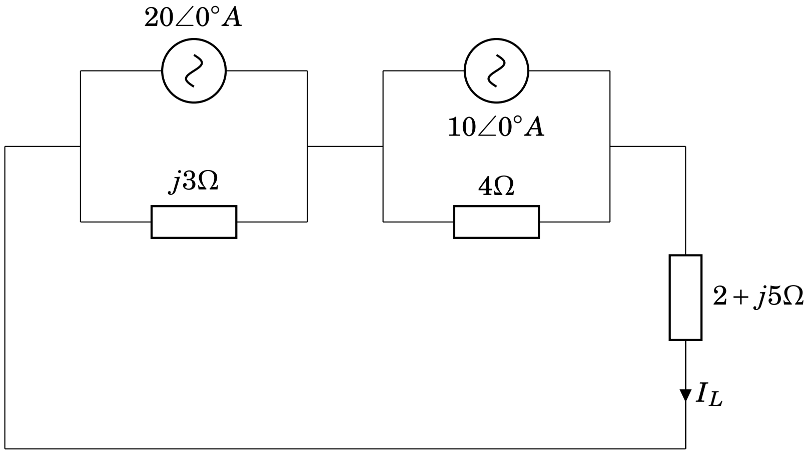


Figure 75

7.17 Problem

In the circuit shown in Figure 76, find the value of E_1 such that the first source operates at unity power factor and the second source operates at zero power factor.

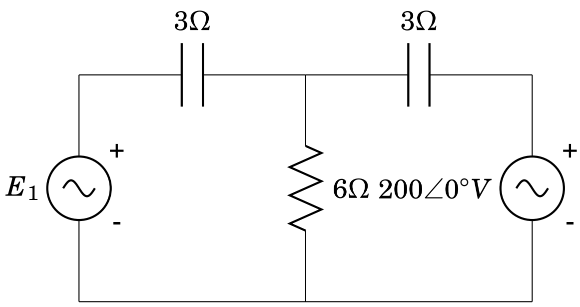


Figure 76

7.18 Problem

In the circuit shown in Figure 77, find I_x. Is the reciprocity theorem is satisfied?

7.19 Problem

In the circuit shown in Figure 78, find V_x. Is the dual of reciprocity theorem is satisfied?

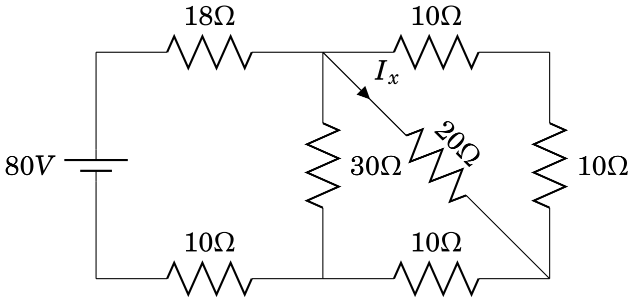


Figure 77

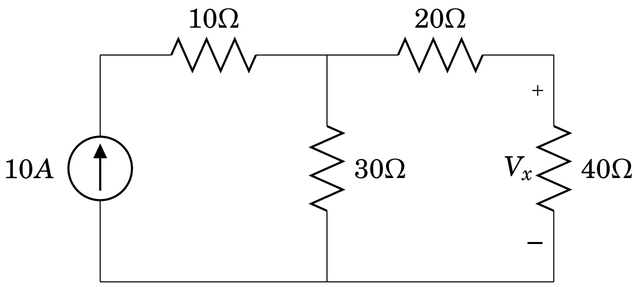


Figure 78

8. The Power in AC Circuit

8.1 Problem

For the circuit shown in Figure 79:

1. Find total active power, total reactive power, total apparent power and input power factor Sketch the network power triangle
2. Find energy dissipated by resistance in full cycle of input voltage if the circuit frequency is 50 Hz
3. Find the stored in or returned by the capacitor or inductor over 0.5 cycle of the power curve for each if the frequency of the input voltage is 50Hz

8.2 Problem

For the circuit shown in Figure 80, Find:

- the active power, reactive power, apparent power and power factor for each branch
- the total number of watts, the total number of VAR, the total number of VA and input power factor

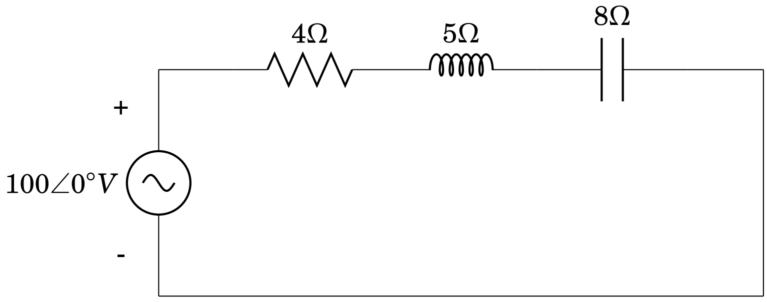


Figure 79

- sketch the power triangle
- the source current

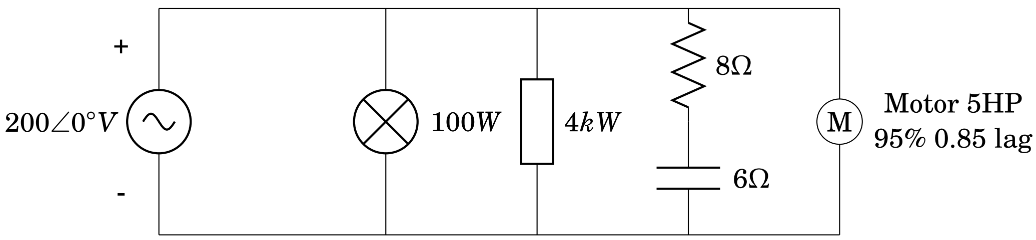


Figure 80

8.3 Problem

For the circuit shown in Figure 81, Find:

1. the total number of watts, the total number of VAR, the total number of VA and input power factor
2. sketch the power triangle

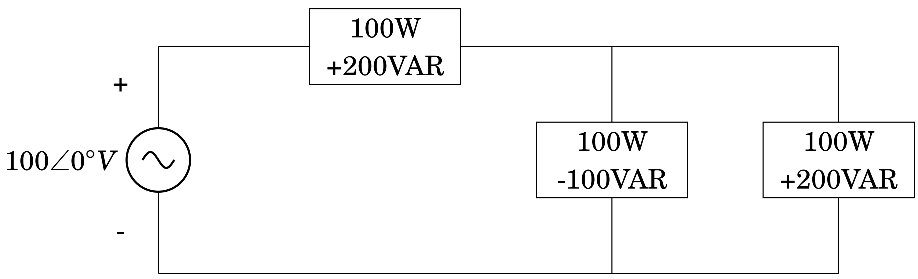


Figure 81

8.4 Problem

For the previous problem, what the parallel capacitors required improving the system power factor to unity?

8.5 Problem

An industrial load consumes 40kW at 0.80 with lagging power factor is fed from $220\angle 0^{circ}$V , 50Hz supply. What the parallel capacitors required to improve the system power factor to:

1. unity
2. 0.90 lagging power factor?

9. Resonance

9.1 Problem (Series Resonance)

The inductive and capacitive reactance of the series circuit shown in Figure 82 are given at resonant frequency of 5kHz, find:

1. the voltage drop across resistor, inductor and capacitor at resonant frequency
2. the circuit quality factor
3. the half power frequencies
4. the band width
5. the power dissipated at half power frequencies

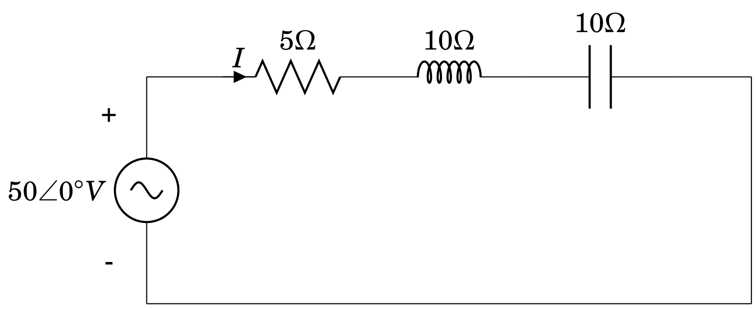


Figure 82

9.2 Problem (Series Resonance)

For the series circuit shown in Figure 83, the resonant frequency of 6kHz and band width of 600Hz, find:

1. the circuit quality factor
2. the value of inductive and capacitive reactance at resonance
3. the circuit inductance in mH and capacitance in μF
4. the half power frequencies
5. the power dissipated at half power frequencies

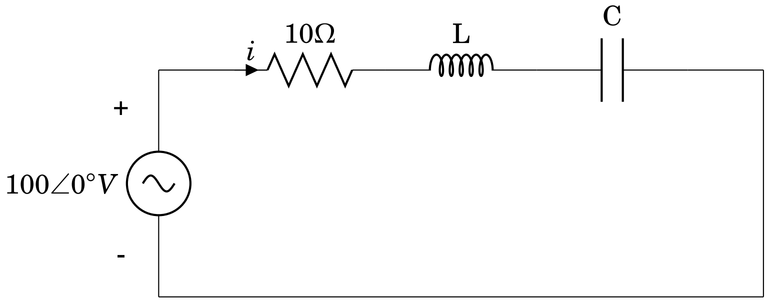


Figure 83

9.3 Problem (Series Resonance)

For the series resonance circuit, the following data are given: the resonant frequency of 12kHz, the circuit resistance is 10Ω and the circuit inductive reactance at resonant frequency is 100Ω. Find:

1. the circuit quality factor
2. the bandwidth
3. the circuit inductance in mH and capacitance in μF
4. the half power frequencies
5. the power dissipated at half power frequencies if the supply voltage is 100V.

9.4 Problem (Series Resonance)

For the series resonance circuit, the following data are given: the resonant frequency of 150kHz, the bandwidth is 8kHz the circuit absorbs 1kW at half power frequencies. Find:

- the circuit resistance if the supply voltage is 200V
- the circuit inductance in μH and capacitance in μF
- the half power frequencies
- the fractional bandwidth

9.5 Problem (Parallel resonance)

For the ideal parallel resonant circuit shown in Figure 84, find:

1. the resonant frequency
2. the capacitor voltage drop at resonance

3. the resistor, inductor and capacitor currents at resonance
4. the quality factor and bandwidth

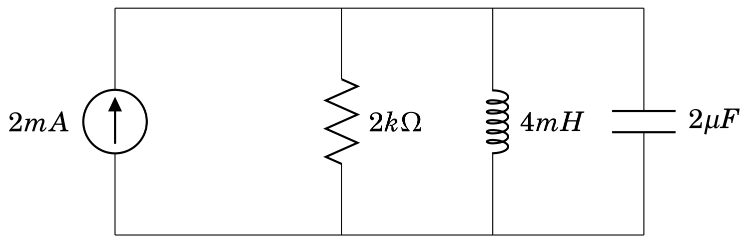


Figure 84

9.6 Problem (Parallel resonance)

For the parallel resonant circuit shown in Figure 85, find:

1. the ideal resonant, the maximum impedance resonant, and unity power factor impedance frequencies
2. the capacitor voltage and branch currents at maximum impedance
3. the capacitor voltage and branch currents at unity power factor impedance
4. the quality factor and bandwidth

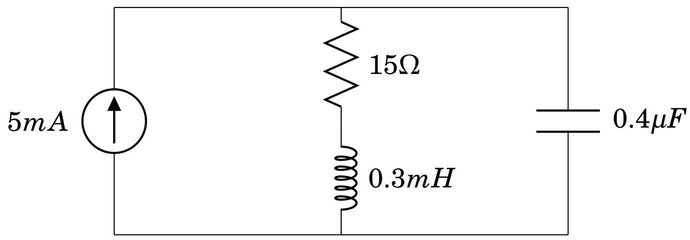


Figure 85

9.7 Problem (Parallel resonance)

For the parallel resonant circuit shown in Figure 86, find:

- the ideal resonant, the maximum impedance resonant, and unity power factor impedance frequencies
- the capacitor voltage and branch currents at maximum impedance
- the capacitor voltage and branch currents at unity power factor impedance
- the quality factor and bandwidth

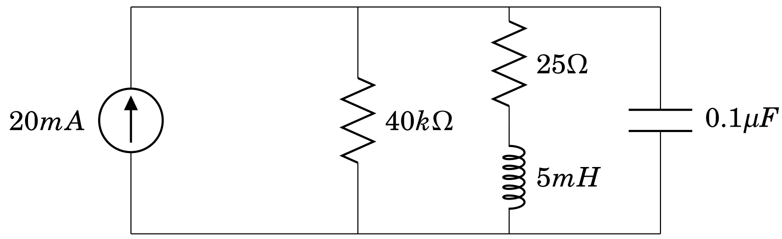


Figure 86

9.8 Problem (Parallel resonance)

For the parallel resonant circuit shown in Figure 87, find:

1. the ideal resonant, the maximum impedance resonant, and unity power factor impedance frequencies

2. the circuit quality factor and bandwidth.

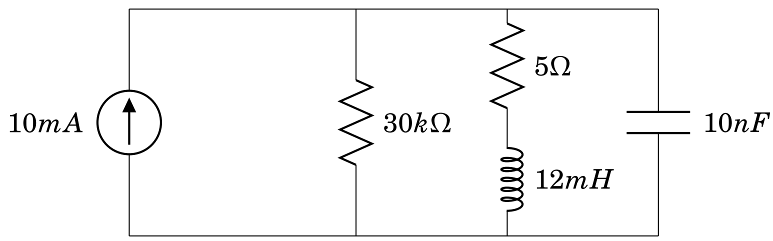


Figure 87

9.9 Problem

Design a parallel resonant to have capacitor voltage at resonant of 15V, circuit bandwidth of 2000 Hz, resonant frequency of 10 kHz. Taking coil of 3mH inductance, and 5Ω resistor and a current source with 10 mA and internal resistance of 50kΩ.

10. Filters

10.1 Problem (Low pass filters)

Design an RC low pass filter to have cutoff frequency of 2kHz and a capacitor of 0.2μF. Sketch the output voltage and phase angle versus log of frequency for the range from 0 to $20f_c$. The input voltage is $20V$.

10.2 Problem (Low pass filters)

Design an RL low pass filter to have cutoff frequency of 1kHz and a resistance of 110Ω. Sketch the output voltage and phase angle versus log of frequency for the range of 0 to $20f_c$. The input voltage is 10V.

10.3 Problem (High pass filters)

A high pass filter consists of series RC circuit with resistor of 40kΩ and capacitor of 400pF.

1. Sketch the output voltage magnitude and its phase angle versus log frequency, if the filter is used for both high and low pass filters.

2. Determine new value of capacitor that can be used to obtain a cutoff frequency of 20kHz.

10.4 Problem (High pass filters)

Design an RL high pass filter to have cutoff frequency of 2kHz and a resistance of 0.4kΩ. Sketch the output voltage and phase angle versus log of frequency for the range of 0 to $20f_c$. The input voltage is 10V.

10.5 Problem (Band pass filters)

For the cascade band pass filter shown in Figure 88, find: frequency range from 40kHz to 60kHz. Then determine the minimum output voltage.

1. the capacitors C_1 for cutoff frequencies of 15kHz and 150kHz for high and low frequancies respectively

2. the filter bandwidth

3. calculate the actual value of output voltage at high cutoff frequency

4. sketch the output voltage versus frequency

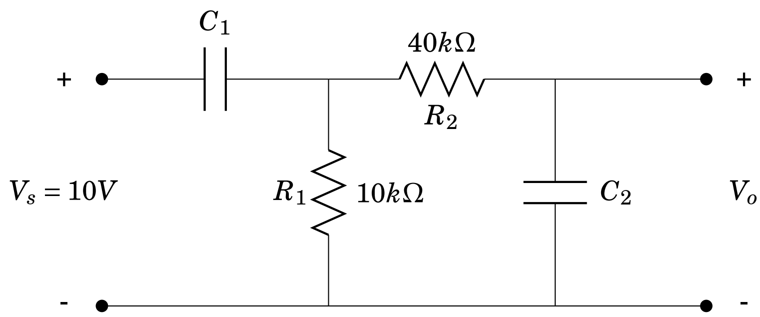


Figure 88

10.6 Problem (Band pass filters)

For he series resonant circuit shown in Figure 89, find:

1. the circuit capacitor for resonance frequency of 50kHz and coil reacance for circuit quality factor of 20.
2. the circuit bandwidth.
3. the maximum output voltage and output voltage at cutoff frequency.
4. sketch the output voltage versus frequency.

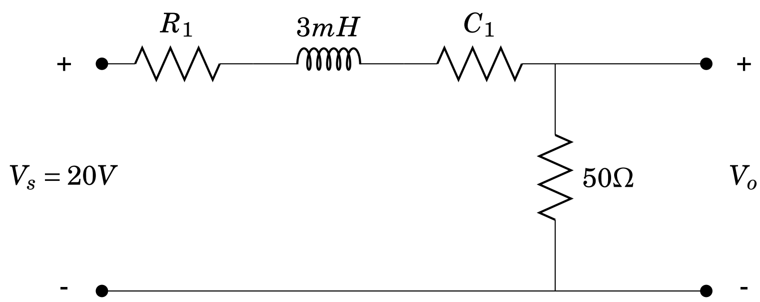


Figure 89

10.7 Problem (Band Reject Filters)

For the above problem, sketch the output voltage versus frequency for the

11. The two ports network

11.1 Problem (Z-Parameters)

Determine the impedance parameters of the network
shown in Figure 90.

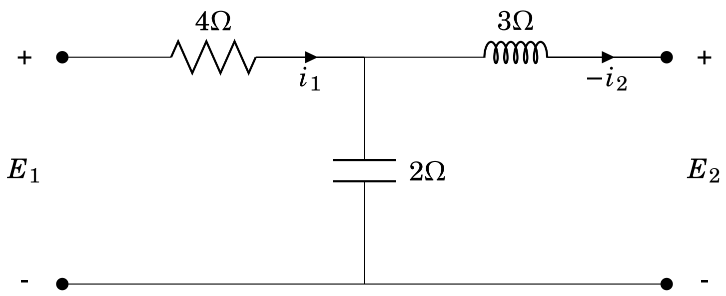


Figure 90

11.2 Problem (Z-Parameters)

For the previous problem, find I_1 and I_2, if the voltages $E_1 = 200\angle 30°$ V and $E_2 = 100\angle 0°$V.

11.3 Problem (Z-Parameters)

Determine the impedance parameters of the circuit shown in Figure 91

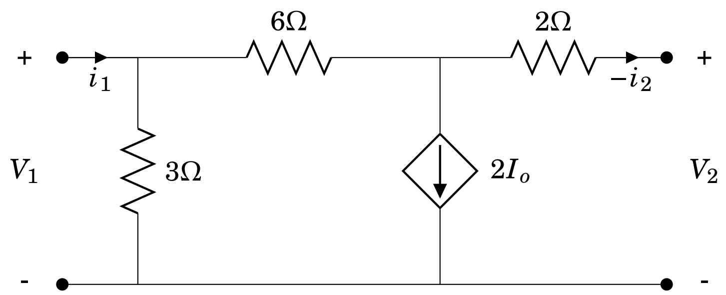


Figure 91

11.4 Problem (Y-Parameters)

Determine the Y parameters of the network shown in Figure 92.

11.5 Problem (Y-Parameters)

Determine the admittance parameters of circuit shown in Figure 90.

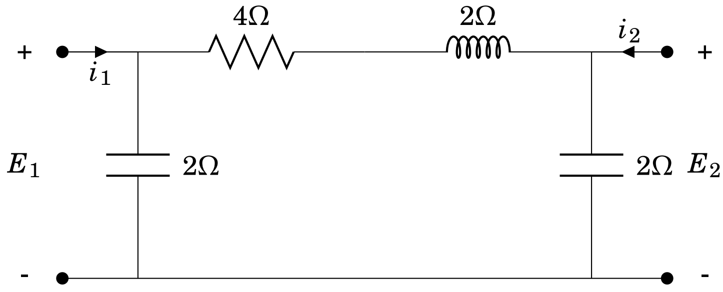


Figure 92

11.6 Problem (H-Parameters)

Determine the hybrid parameters of the network shown in Figure 93

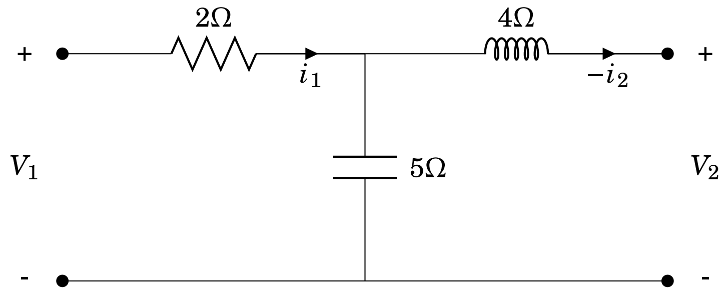


Figure 93

11.7 Problem (H-Parameters)

Find the Thevenin equivalent at the output port of the circuit shown in Figure 94.

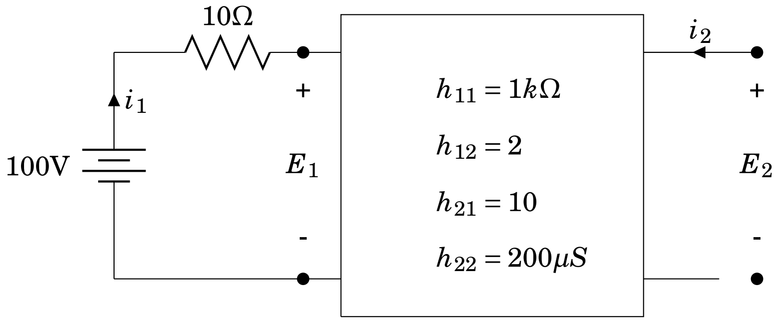


Figure 94

11.8 Problem (T-Parameters)

Determine the transmission parameters of the circuit shown in Figure 95.

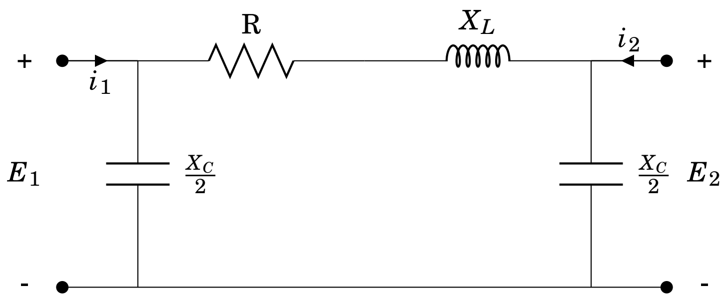


Figure 95

Circuit solvers and netlists

12. Netlist and file types

The basic input file for PSpice is a text (ASCII) file that has the file type "CIR." This will be created by manually as the primary method of presenting the circuit to the PSpice program. You may use text editor that saves in text or ASCII format like notpad. It should be noted the schematic editor are mainly creating the CIR file from graphical user interface. The output file always generated by PSpice is a text (ASCII) file that has the file type "OUT." I.e., if you submit a data file to PSpice named "eqCircuit.CIR," it will create an output file named "eqCircuit.OUT." This output file is created even for unsuccessful run due to input errors. The OUT file has information about the circuit and calculated results like voltages, currents and power. For tranisent analysis, with large data PSpice can save the numerical data in a *.DAT file. The aforementioned *.DAT file is by default a binary (i.e., non-ASCII) file that requires a MicroSim application called PROBE for you to see the data.

Another common file type used by experienced PSpice users is the "*.INC" (include) files. These enable us to store frequently used modules that have not yet been added to a library. Include files are accesable with a single command line in the *.CIR file. Other files used with PSpice are "*.LIB" files where the details of complex parts are saved.

13. Essential Syntax

The syntax of netlist obay the following rules.

- PSpice is not case sensitive.
- All element names must be unique. .
- The first line in the CIR file is used as a title.

- There must be a node designated "0." (Zero) This is the reference node against which all voltages are calculated.
- Each node must have at least two elements attached to it.
- The last line in any data file must be ".END" command.
- All lines that are not blank (except for the title line) must have a character in the leftmost position on the line.
  1. Use "*" (an asterisk) in column 1 in order to create a comment line.
  2. Use "+" (plus sign) in column 1 in order to continue the previous line (for better readability of very long lines).
  3. Use "." (period) in column 1 followed by the rest of the "dot command" to pass special instructions to the program.
  4. Use the designated letter for a part in column 1 followed by the rest of the name for that part (no spaces in the part name).
- Use "whitespace" (spaces or tabs) to separate data fields on a line.
- Use ";" (semicolon) to terminate data on a line if you wish to add commentary information on that same line.

14. Numbers and units

PSpice is a computer program used mostly by engineers and scientists. Therefore, presntation of large and small numbers are required. That would implemented in everyday practice using units and exponents. PSpice introduces two methods to write large ans small numbers. The implementation of units using reserved letters for each unit as shown in 1. An alternative to this type of notation, which is in fact, the default for PSpice output data, is "textual scientific notation." This notation is written by typing an "E" followed by a signed or unsigned integer indicating the power of ten.

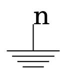
15. Basic circuits

The electric circuit is a collection of electrical components. Each component is defined by a number of terminals. The most basic passive elements line resistor, inductor and capacitor has two terminals, similarly the ecurrent and voltage sources. Electronic components and subcricuits may have three or more terminals. A spcial exception is the ground point that has one terminal. PSpice reserves a spcific letter to define each basic elements and uniqe name to define advanced components. For example, the letter V is reserved for ideal DC coltage supply. The essential step is to provide spcial idetification name that me be a number or a text. It is common practice to use numbers. However, their sequance has no segnificance at all. Only one critical exeption is the ground point that must be define

with number zero. The following section will domenstrate the PSpice syntax to define each element. The element defintion usually associated with a graphical defintion of the relation between currents and voltage directions.

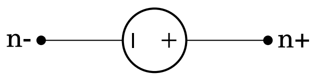
15.1 Ground

The ground is the essential elementthat should be defined in each circuit. In netlist text the ground is defined with a node number of zero. On the other hand, it would be critical to insert the ground at least once while using schematic editors.



15.2 Ideal voltage source

The beginning letter of the part name for all versions of the ideal independent voltage source is "V." The name is followed by the positive node designation, then the negative node designation, then an optional tag: "DC" followed by the value of the voltage. The tag "DC" (or "dc" if you prefer) is optional because it is the default. One of the interesting uses of ideal independent voltage sources is that of an ammeter. We can take advantage of the fact that PSpice saves and reports the value of current entering the positive terminal of an independent voltage source. If we do not actually require a voltage source to be in the branch where we want to measure the current, we simply set the voltage source to a zero value.



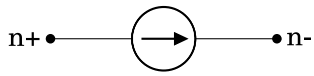
15.3 Ideal current source

The name of an ideal independent current source begins with the letter "I" in column 1 of the data file. Since the current source, is an active element, it matters greatly how it is

Value	Prefix	Common Name
$10^{1}2$	T or t	Tera
10^{9}	G or g	Giga
10^{6}	Meg or meg	Mega
10^{3}	K or k	Kilo
$10^{-}3$	M or m	milli
$10^{-}6$	U or u	micro
$10^{-}9$	N or n	nano
$10^{-}12$	P or p	pico
$10^{-}15$	F or f	femto

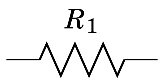
Table 1: Metric units prefix designations

connected. Designated current flows into the node written on the left, through the current source, out the node written on the right. As with the independent voltage source, the default type is DC. Remember that the so-called +node on a current source may have a negative voltage with respect to the so-called -node. This is due to the fact that the circuit external to the current source determines its voltage.



15.4 Resistor

The first letter of the name for a resistor must be "R." The name is followed by the positive node, then the negative node and then the value in ohms or some multiple of ohms. The value of resistance will normally be positive. Negative values are allowed in order to permit an alternative model of an energy source. A value of zero, however, will produce an error. The resistor is not an active device, so the polarity of its connection has no effect on the values of the voltages and currents reported in the solution. However, the current through a resistor is reported as that which flows from the node on the left to the node on the right in the source code line in which the resistor is entered.



15.5 DC sweeps and .PRINT command

One of the many "dot commands" in PSpice is the .PRINT command. It has many uses, but we will concentrate here on using it for printing DC voltages and currents.

The .PRINT command can be repeated as often as necessary in an analysis. However, we must keep in mind that the .PRINT command was designed to work with a DC or an AC sweep. This is a method of varying a parameter over a range of values so that we get a batch of cases solved all at once. For now, let's look at the syntax for a DC sweep command with the default linear type range.

Name	+node	-node	type	value	comment
Va	4	2	DC	16.0V;	V after 16.0 is optional
v1	qe	qc	dc	24m;	qe is +node and qc is -node
VWX	23	14		18k;	dc not really needed
vwx	14	23	DC	-1.8E4;	same as above
Vdep	15	27	DC	0V;	V-source used as ammeter

Table 2: Parameters of ideal DC voltage source and examples

Name	+node	-node	type	value	comment
Icap	11	0	DC	35m;	35mA flows from node 11 to 0
ix	79	24	dc	1.7;	DC not needed
I12	43	29	DC	1.5E-4;	
I12	29	43	dc	-150uA;	same as above

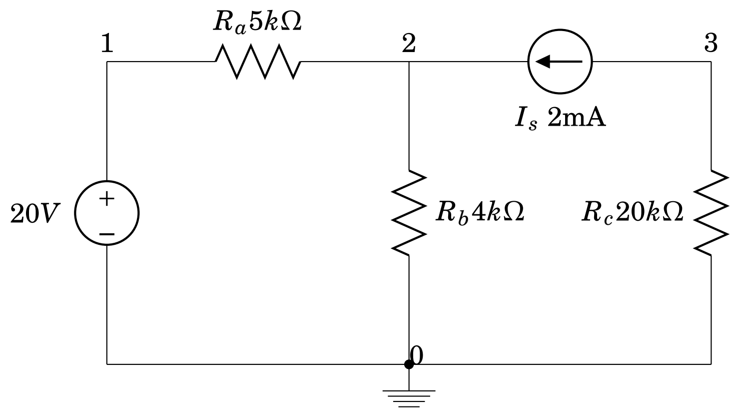
Table 3: Parameters of ideal DC current source and examples

Name	+node	-node	value	comment
Rabc	31	0	14k;	reported current from 31 to 0
Rabc	0	31	14k;	reported current changes sign
rshnt	12	15	99m;	0.099 ohm resistor
Rbig	19	41	10MEG;	10 meg-ohm resistor

Table 4: Parameters of resistance and examples

15.6 Example

Write netlist code scribt for the teh circuit shown. Print the current and voltage of each resistance.



Example solution
Vs 1 0 DC 20.0V ; note the node placements
Ra 1 2 5.0k
Rb 2 0 4.0k
Rc 3 0 1.0k
Is 3 2 DC 2.0mA ; note the node placements
.DC Vs 20 20 1 ; this enables the .print commands
.PRINT DC V(1,2) I(Ra)
.PRINT DC V(2) I(Rb)
.PRINT DC V(3) I(Rc)
.END

Command	Type	list or required values
.PRINT	DC	V(1) V(2) V(3) ;prints the node voltages
.PRINT	DC	V(1,2) ;prints the voltage across Ra
.PRINT	DC	I(Rb) I(Rc) ;prints the currents through Rb and Rc
.PRINT	DC	V(1,2) I(Ra) ;voltage and current for Ra
.PRINT	DC	V(2,0) I(Rb) ; V(2,0) same as V(2)

Table 5: Examples of using .PRINT command

Command	Sweep Variable	Starting	Stopping	Increment
.DC	Vs	20.0	20.0	1.0

Table 6: Parameters of DC sweep command